

MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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May 8, 1863.

No. 7.

G. B. AIRY, Esq., Astronomer Royal, in the Chair.

Henry Johnson, Esq., 39 Crutched Friars;

Celestin Baume, Esq., Baume Lodge, East Brixton; and

Lieut. Geo. Lyon Tupman, Royal Marine Artillery,

were balloted for and duly elected Fellows of the Society.

On Solar Spots, and on the Variable Star α (Argo) Navis.
By Prof. Wolf.

(Translation of part of a Letter to the Astronomer Royal, dated
Zurich, 1863, April 2.)

"In a short time I shall have the honour to lay before you the fifteenth number of my communications concerning the Solar Spots. At present I give you its principal contents, and I shall be much rejoiced if you consider this sufficiently interesting to be communicated to the Royal Astronomical Society. In the first place, I have determined, by means of my own observations, together with those of Herr Schwabe at Dessau, and Herr Jenzer at Berne, the mean relative number for the year 1862, and I have now for

	1858	1859	1860	1861	1862
the relative numbers	50.9	96.4	98.6	77.4	59.4

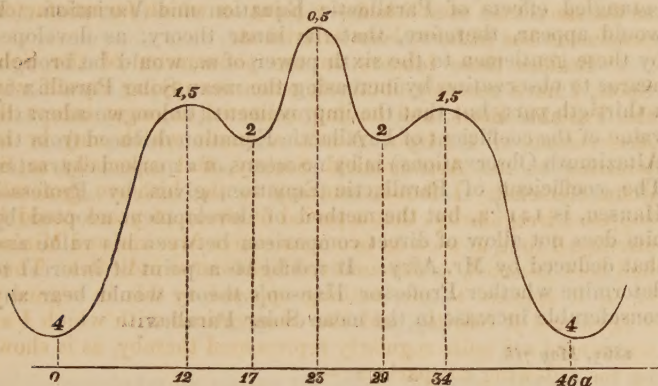
so that the Maximum which I had determined for 1860.2 is already very beautifully shown in these numbers. From the number, 59.4, corresponding to 1862, I have obtained, according to the formulæ laid down by me, for the year 1862, for Munich 9.27, and for Prague 8.38, as the mean declination variation. In the second place, I have not to enter here into some additions to the collection of formulæ in No. 13, in conjunction with one of my colleagues, Herr Fritz, made a new comparison between the phenomena of the Solar Spots and of the Northern Lights, which has yielded very interesting results. That is to say, evidence is afforded by it that the two phenomena form parallel curves, and not only does the *eleven-year period* show itself in the Aurora, but also the *greater period of about 56 years*, which I have referred to in No. 12 as becoming apparent in the case of the Solar Spots. By this labour, therefore, the secular period of the Aurora Borealis is at the same time established—a point on which no satisfactory conclusion has hitherto been arrived at.

“Besides these labours on the phenomena of the Solar Spots, I have recently obtained, when occupying myself with the Variable Stars, and having collected amongst others the observations of *π (Argo) Navis*, a result which may be interesting to the Astronomical Society, and especially to Sir John Herschel. I found, contrary to the hitherto generally supposed irregularity, that a period of about 46 years could be attributed to it, as soon as two consecutive Maxima and Minima had been inserted, as the annexed light-curve indicates. There is, as it appears to me, nothing opposed to this in regard to *β Lyrae* and *R Sagittæ*, and the observations with which I am acquainted are quite regularly represented thereby, as is shown by the following comparison:—

Phase.	Hypothesis.		Observation.		Observer.
	Magnitude.	Time.	Time.	Magnitude.	
Minim.	4	1677	1677	4	Halley.
Minim.	4	1723			
Cons. Max.	1.5	1735			
Cons. Min.	2	1740			
Maxim.	0.5	1746	1751	2	Lacaille.
Cons. Min.	2	1752			
Cons. Max.	1.5	1757			
Minim.	4	1769			
:					
Minim.	4	1815	1815	4	Burchell.
			1824	2	Brisbane.
Cons. Max.	1.5	1827	1827	1.5	Burchell.
Cons. Min.	2	1832	1832	2	Johnson.
			1835	1.5	Herschel.

Phase.	Hypothesis.		Observation.		Observer.
	Magnitude.	Time.	Time.	Magnitude.	
Maxim.	0.5	1838	1838	0.5	Herschel.
			1842	1	Maclear.
Cons. Min.	2	1844	1845	1	Jacob.
Cons. Max.	1.5	1849	1850	1	Gilliss.
			1856	1.5	Powell.
			1859	3.1	Ditto.
Minim.	4	1861	1861	3.6	Ditto.

“Possibly there may exist other observations unknown to me, which may overthrow my system, but the trial of my hypothesis would be always worthy of attention.”



(Note. The figures 4, 2, &c. in the diagram evidently denote that the star's brightness will at these times be of the 4th magnitude, 2d magnitude, &c.—G.B.A.)

The Notes of Phase, which have been printed “cons.” (consecutive) are in the original “sec.,” conceived to have the same meaning.

The descriptions of Phase evidently ought to be these,—

Minimum.	Minimum.
Minimum.	1st Max.
1st Max.	1st Min.
1st Min.	Maximum.
Maximum.	2d Min.
2d Min.	3d Max.
3d Max.	Minimum.
Minimum.	

Note on the Coefficient of the Parallactic Equation in the Lunar Theory. By E. J. Stone, Esq.

The literal expressions of the coefficient of Parallactic Equation, developed to the sixth power of the small quantities, are identical in the theories of Plana, Pontécoulant, and Lubbock: the numerical value deduced with the usually received values of the constants, amounts to $122''.1$; if we increase the mean Solar Parallax by a thirtieth part, the coefficient becomes $126''.2$; the value deduced by the Astronomer Royal from the Greenwich Lunar Reduction is $124''.7$; the value, however, given by the Altazimuth Observation alone amounted to $125''.5$. The Astronomer Royal remarks in his Memoir that the Altazimuth Observations possess the rare advantage of having been extended to portions of every lunation very near to the conjunction of Sun and Moon, and thereby of discriminating between the entangled effects of Parallactic Equation and Variation. It would appear, therefore, that the lunar theory, as developed by these gentlemen to the sixth power of m , would be brought nearer to observation by increasing the mean Solar Parallax by a thirtieth part, but that the improvement (unless we adopt the value of the coefficient of Parallactic Equation deduced from the Altazimuth Observations) is by no means of a marked character. The coefficient of Parallactic Equation, given by Professor Hansen, is $121''.4$, but the method of development adopted by him does not allow of direct comparison between his value and that deduced by Mr. Airy. It would be a point of interest to determine whether Professor Hansen's theory would bear any considerable increase in the mean Solar Parallax.

1863, May 7th.

On the Acceleration of the Mean Motion of the Moon.

In the *Berichte der K. Sächs. Gesellschaft zu Leipzig*, 15 April, 1863, is contained a short paper by Prof. Hansen, "Einige Bemerkungen über die Säcular-änderung der mittleren Länge des Mondes." The value of the acceleration, as calculated by Adams and Delaunay, is considerably—nearly $6''$ —less than that employed in the author's Lunar Tables; such smaller value cannot, however (as he has shown, *Comptes Rendus*, t. l., 1860), represent the ancient eclipses; and assuming that it is the correct value of the acceleration arising from the change in the excentricity of the solar orbit, the deficiency must be accounted for by other causes. That which most naturally presents itself is a change in the length of the

sidereal day, or period of the Earth's rotation; and he remarks that Laplace's demonstration of the invariability of the sidereal day depends on the very assumption that the acceleration is *wholly* accounted for by the change of the excentricity of the solar orbit, and consequently must in the present question be put aside. He proceeds to show that the deficiency of $6''$ in the acceleration would be accounted for by an alteration of the sidereal day by the almost infinitesimal increase of $0^s.01197$ in the course of 2000 years; and he remarks that the same alteration would produce a secular alteration of about $1''.9$, consequently a sensible effect in the mean longitude of *Mercury*, the motion of which planet, as shown by Leverrier, is not completely accounted for by existing theories. Would the supposition in question produce a better agreement of the theory of *Mercury* with observation? This question he considers so important, that he cannot help expressing the wish that it may be soon undertaken. But in the meantime it is remarkable that the value of acceleration, as obtained by the author, without the assumption of any such supplementary cause, should agree so well with the observations, and that the small changes in the values of the secular variations to which his latest calculations have led him should produce a still better agreement. He in fact finds that to the coefficients of the secular variations of his Lunar Tables there should be added

for Mean Longitude	+ $0''.365$
„ Perigee	— $1''.352$
„ Node	— $0''.464$

and he concludes by stating the effect of these changes on the eclipses of Thales, Agathocles, Stiklastadt, and Ennius, and on two eclipses in the years 1567 and 1605 respectively.

Note on Plana's Lunar Theory. By A. Cayley, Esq.

I have been much surprised to find that there is an error of the order $m^2 \gamma^4$, arising from the omission of a factor $(1 + \gamma^2)^{-1}$, in the expression for $\frac{d^2 \delta u}{dv^2} + \delta u$, as given by the equation (II) (*Théorie de la Lune*, t. i. p. 267), being the equations made use of in the theory for the determination of δu , the perturbation of the reciprocal of the radius vector. This error may probably be the cause of some of the discrepancies in the terms of the fourth and higher orders, between Plana's results and those of Pontécoulant and Delaunay.

Plana's equation (6) t. i., p. 260, is

$$\begin{aligned} \frac{d^2 \delta u}{d v^2} + \delta u &= a R'' \\ &+ f(e, \gamma) Q' e \cos(c v - \int \varpi d v) \\ &- \left\{ f(e, \gamma) (1 + \gamma^2) (1 + s^2)^{-\frac{3}{2}} - \frac{a (1 + s^2)^{-\frac{3}{2}}}{a, \psi(e, \gamma)} \right\} \\ &+ f(e, \gamma) P \gamma^2 (1 + s^2)^{-\frac{3}{2}} \Theta, \end{aligned}$$

if for shortness

$$\Theta = \frac{3}{8} \gamma^2 - \left(1 + \frac{1}{2} \gamma^2\right) \cos(2 g v - 2 \int \theta d v) + \frac{1}{8} \gamma^2 \cos(4 g v - 4 \int \theta d v).$$

R'' (p. 256) should be

$$R'' = \frac{1}{\sigma a, \psi(e, \gamma)} \frac{\Omega_2 - \frac{d u}{d v} \frac{d \Omega}{u^2 d v} - \sigma (1 + s^2)^{-\frac{3}{2}} 2 \int U d v}{1 + 2 \int U d v},$$

but, by an error which is implicitly corrected, the σ which multiplies $(1 + s^2)^{-\frac{3}{2}} 2 \int U d v$ is omitted. Hence the equation (6) becomes

$$\begin{aligned} (1 + 2 \int U d v) \left(\frac{d^2 \delta u}{d v^2} + \delta u \right) &= \\ \frac{a}{\sigma a, \psi(e, \gamma)} \left\{ \Omega_2 - \frac{d u}{d v} \frac{d \Omega}{u^2 d v} - \sigma (1 + s^2)^{-\frac{3}{2}} 2 \int U d v \right\} \\ &+ (1 + 2 \int U d v) f(e, \gamma) Q' e \cos(c v - \int \varpi d v) \\ &- (1 + 2 \int U d v) \left\{ f(e, \gamma) (1 + \gamma^2) (1 + s^2)^{-\frac{3}{2}} - \frac{a (1 + s^2)^{-\frac{3}{2}}}{a, \psi(e, \gamma)} \right\} \\ &+ (1 + 2 \int U d v) f(e, \gamma) P \gamma^2 (1 + s^2)^{-\frac{3}{2}} \Theta, \end{aligned}$$

in which equation

$$\Omega_2 = \frac{d \Omega}{d u} + \frac{s}{u} \frac{d \Omega}{d s}, \text{ pp. 26, 245, } \frac{d \Omega}{u^2 d v} = \frac{\sigma a,}{\lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}}} U, \text{ p. 265,}$$

$$\psi(e, \gamma) = \lambda^{-\frac{3}{2}} (1 + \gamma^2)^{-\frac{1}{2}}, f(e, \gamma) = \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}}, \text{ p. 261.}$$

But retaining for greater convenience the function $f(e, \gamma)$ in two of the terms, we have

$$\begin{aligned}
 & (1 + 2 \int U dv) \left(\frac{d^2 \delta u}{dv^2} + \delta u \right) = \frac{a}{\sigma a_1} \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} \left\{ \frac{d\Omega}{du} + \frac{s}{u} \frac{d\Omega}{ds} \right. \\
 & \quad \left. - \frac{\sigma a_1}{\lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}}} U \frac{du}{dv} - \sigma (1 + s^2)^{-\frac{3}{2}} 2 \int U dv \right\} \\
 & + (1 + 2 \int U dv) f(e, \gamma) Q' e \cos(c v - \int \varpi dv) \\
 & - (1 + 2 \int U dv) \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} \left\{ (1 + s^2)^{-\frac{3}{2}} - \frac{a}{a_1} (1 + s^2)^{-\frac{3}{2}} \right\} \\
 & + (1 + 2 \int U dv) f(e, \gamma) P \gamma^2 (1 + s^2)^{-\frac{3}{2}} \Theta \\
 = & \frac{a}{\sigma a_1} \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} \left(\frac{d\Omega}{du} + \frac{s}{u} \frac{d\Omega}{ds} \right) \\
 & - a U \frac{du}{dv} \\
 & - \frac{a}{a_1} \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} (1 + s^2)^{-\frac{3}{2}} 2 \int U dv \\
 & + (1 + 2 \int U dv) f(e, \gamma) Q' e \cos(c v - \int \varpi dv) \\
 & - (1 + 2 \int U dv) \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} \left\{ (1 + s^2)^{-\frac{3}{2}} - \frac{a}{a_1} (1 + s^2)^{-\frac{3}{2}} \right\} \\
 & + (1 + 2 \int U dv) f(e, \gamma) P \gamma^2 (1 + s^2)^{-\frac{3}{2}} \Theta.
 \end{aligned}$$

which is

$$\begin{aligned}
 = & \frac{a}{\sigma a_1} \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} \left(\frac{d\Omega}{du} + \frac{s}{u} \frac{d\Omega}{dv} \right) \\
 & - a U \frac{du}{dv} \\
 & - \frac{a}{a_1} \lambda^{\frac{2}{3}} (1 + \gamma^2)^{\frac{4}{3}} (1 + s^2)^{-\frac{3}{2}} 2 \int U dv \text{ (destroyed by term } \textit{infra}) \\
 & + (1 + 2 \int U dv) f(e, \gamma) Q' e \cos(c v - \int \varpi dv)
 \end{aligned}$$

$$\begin{aligned}
& -\lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}} \left\{ (1 + s^2)^{-\frac{3}{2}} - \frac{a}{a_1} (1 + s^2)^{-\frac{3}{2}} \right\} \\
& - \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}} (1 + s^2)^{-\frac{3}{2}} 2 \int U dv \\
& + \frac{a}{a_1} \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}} (1 + s^2)^{-\frac{3}{2}} 2 \int U dv \text{ (destroyed by term *suprà*)} \\
& + (1 + 2 \int U dv) f(e, \gamma) P \gamma^2 (1 + s^2)^{-\frac{3}{2}} \odot;
\end{aligned}$$

or, putting $u = \frac{1}{a} (u_1 + \delta u)$, this becomes

$$\begin{aligned}
& (1 + 2 \int U dv) \left(\frac{d^2 \delta u}{dv^2} + \delta u \right) \\
& = \frac{a}{\sigma a_1} \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}} \left(\frac{d\Omega}{du} + \frac{s}{u} \frac{d\Omega}{dv} \right) \\
& - U \left(\frac{du_1}{dv} + \frac{d\delta u}{dv} \right) \\
& - \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}} (1 + s^2)^{-\frac{3}{2}} 2 \int U dv \\
& + (1 + 2 \int U dv) f(e, \gamma) Q' e \cos(c v - \int \varpi dv) \\
& - \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}} \left\{ (1 + s^2)^{-\frac{3}{2}} - \frac{a}{a_1} (1 + s^2)^{-\frac{3}{2}} \right\} \\
& + (1 + 2 \int U dv) f(e, \gamma) P \gamma^2 (1 + s^2)^{-\frac{3}{2}} \odot,
\end{aligned}$$

agreeing with the Formula II. p. 265, except that in Plana's last term, instead of the factor $f(e, \gamma)$ ($= \lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}}$), we have the factor $\lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}}$. That is, the last term, as given by Plana, should be divided by $1 + \gamma^2$. And this error is introduced from the formula (II.) into the formula (II.)', p. 267, viz., the incorrect factor $\lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}}$ is there replaced by its value q ; whereas, the true value being $\lambda^{\frac{3}{2}} (1 + \gamma^2)^{\frac{1}{2}}$, the factor in (II.)' should be $= \frac{q}{1 + \gamma^2}$.

The corrected formula (II.)' is

$$-\frac{d^2 \delta u}{dv^2} - \delta u = -Q' \frac{q e}{1 + \gamma^2} \cos(c v - \int \varpi dv)$$

$$\begin{aligned}
 & + q \left\{ (1 + s^2)^{-\frac{3}{2}} - \frac{a}{a_1} (1 + s^2)^{-\frac{3}{2}} \right\} \\
 & + \mu^2 (R_4 + R_5) - \mu^2 \left(\frac{du}{dv} + \frac{d^2 u}{dv^2} \right) R, \\
 & - 2 \mu^2 \left\{ \frac{d^2 \delta u}{dv^2} + \delta u + q (1 + s^2)^{-\frac{3}{2}} \right. \\
 & \quad \left. - \frac{Q' q e}{1 + \gamma^2} \cos (c v - \int \varpi dv) \right\} \int R, dv \\
 & - P q \gamma^2 (1 + \gamma^2)^{-1} (1 + s^2)^{-\frac{3}{2}} (1 - 2 \mu^2 \int R, dv) \left\{ \frac{3}{8} \gamma^2 \right. \\
 & \quad \left. - \left(1 + \frac{1}{2} \gamma^2 \right) \cos (2 g v - 2 \int \theta dv) + \frac{1}{8} \gamma^2 \cos (4 g v - 4 \int \theta dv) \right\}.
 \end{aligned}$$

Observing that P is of the order m^2 , and that q is approximately equal to unity, the error in $\frac{d^2 \delta u}{dv^2} + \delta u$ is of the order $m^2 \gamma^4$, as noticed above. It may be right to mention that I obtained the correction in the first instance by starting from the fundamental equations, and not as here from the intermediate equation (6), so that there is not in that equation any error afterwards implicitly corrected in the transformation to (II)'.

Jupiter's Satellites: Are they visible to the naked Eye?

By C. Mason, Esq.

Last evening, on seeing *Jupiter* shining with peculiar brightness in a stretch of sky perfectly clear for some distance around him, I determined upon trying the experiment suggested by one of the Secretaries at the last meeting of the Society, — that of looking for the Satellites of *Jupiter* with the unassisted eye.

On steadying my gaze on the planet, I noted that the rays or streamers surrounding it were five in number, each of them distinct and clearly defined. They were placed nearly as shown in the accompanying rough sketch (see figure A), the widest space or interval between any two points being on the western side of the planet, or to my right hand.

After steadily gazing until I had slowly counted twenty, I suspected flashes of a minute luminous point of blue colour, on the western point of the planet, in the space before mentioned. By the time I had counted thirty the point became fixed and

intensely brilliant. Its position was slightly above an imaginary line drawn parallel to the horizon, through the centre of the



blaze of the planet, and distant rather more than one apparent diameter from *Jupiter's* limb.

Three times successively I withdrew my eyes from the planet, and again, on each occasion, picked up the little star, and always found it in the same position. (See same figure.)

The time of the last observation was 10.14 P.M., G.M.T.; the whole of the observations, from first to last, occupying probably from eight to ten minutes.

I should mention that I applied a kind of test of what I saw, or thought I saw, by inclining my head first to the right and then to the left hand. On these occasions I noticed that the rays or streamers attached to the planet moved round its diameter in the same direction as I moved my head; but the little star was a fixture in its position, and remained visible until, by inclining my head further to the right, the nearest ray or streamer came over and obscured it, the ray having moved round the planet towards the west. The same obscuration took place by the south-western ray, which travelled westward round the planet when I inclined my head towards the east.

On reaching my residence, I first made a sketch of the appearances I have attempted to describe, and then, at 11.15 P.M., turned my refractor, of $4\frac{7}{8}$ -inches aperture and 6 ft. 6 in. focal length, upon *Jupiter*, and observed that the whole of the satellites were on the western side, and placed somewhat thus (see figure B).



In the same field, and near the Satellites, were two minute fixed stars, shown also in the sketch.

Until I had referred to the *Nautical Almanac*, a few

minutes before using the telescope, I had not the slightest conception of the relative positions of the Planet and its Satellites for that evening. I therefore am the more strongly impressed with a conviction of having seen the Satellites with the naked eye.

16 Queen's Road, Regent's Park,
April 16th, 1863.

Phenomena of Jupiter's Satellites and Occultations of Stars by the Moon. Observed by S. Gorton, Esq.

The accompanying observations were taken more with a view of recording unusual phenomena than for the purpose of giving the absolute time of the occurrence, although I believe that to be approximately correct.

As it has been frequently noticed that the stars reappear after being occulted, I have been anxious to observe whether such an occurrence would take place when positively watched for. With the exception of very great "oscillation" on the part of *Jupiter's* Second Satellite, on the 26th ult., I did not perceive anything unusual.

Jupiter's Satellites: Occultations of Stars by the Moon:
observed at Downs Road, Clapton.

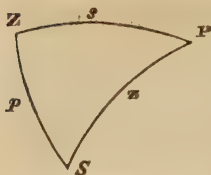
Approximate Longitude, 14° W.

		Local Sid. Time.		
		h	m	s
1863. April 19	Eclipse: Reappearance of Jupiter's 2d Satellite ...	11	5	9
	(The Satellite was two seconds or more in reappearing; the time therefore is not correct to the exact second.)			
26	Occultation of Jupiter's 2d Satellite:			
	Satellite in contact ...	10	56	0
	„ bisected ...	11	0	0
	„ 3 parts covered ...	11	2	0
	„ disappeared at ...	11	3	0
	(The Occultation occupied nearly seven minutes, during which time, owing apparently to the movement of the atmosphere, the Satellite seemed to disappear and appear again several times.)			
26	The Star α Cancri was occulted by the Moon at ...	12	1	30
29	The Star ϵ Leonis was occulted at ...	12	57	4

(In both cases the Occultation took place at the Moon's dark limb, and was sharp and instantaneous.)

Telescope 4 feet focal length; $3\frac{1}{8}$ inches aperture.

On the Solution of some Problems in Nautical Astronomy. By
Major-General Hannington, late of the Bengal Army.



In the spherical triangle ZPS;

$$\cos P = \frac{\cos p - \cos z \cos s}{\sin z \sin s}$$

$$= \cot z \cot s (1 - \sec z \sec s \cos p), \quad (1)$$

also,

$$\begin{aligned} \cos p &= \cos z \cos s + \sin z \sin s \cos P \\ &= \cos z \cos s (1 + \tan z \tan s \cos P), \end{aligned} \quad (2)$$

and moreover

$$\frac{\sin z}{\sin Z} = \frac{\sin p}{\sin P} = \frac{\sin s}{\sin S}. \quad (3)$$

The equations marked (1) and (2) are merely transformations. Their symmetry is remarkable, and they appear to be well suited for use in the only two cases that occur in practice, namely,—

(1.) Having three sides, to find the angle opposite to one of them.

(2.) Having two sides and the angle between them, to find the third side.

In either case, the other parts may be found by means of formulæ (3).

If P be the pole, Z the zenith, S the sun or a star, then the angles at those points may be called those of Time, Azimuth, and Position; also, the sides p , z , s , will represent Zenith distance, Polar distance, and Co-latitude.

It is further to be noted, that if a side or an angle exceed 90° , then the affection of the cosine, secant, tangent, and co-tangent of that side or angle is supposed to change and become negative. The cases in which this occurs must be interpreted accordingly.

Formula (1) is applicable to the finding of the Hour-angle, or the Azimuth of a heavenly body, at the instant when its Altitude was observed. By aid of formula (3), a slightly extended process will determine both of these at one operation.

Formula (2) will serve to determine the Altitude of an object when its Hour-angle is known, or the distance between two objects whose Right Ascension and Declination are known. It is, therefore, applicable to the clearing of a Lunar Distance, or to the finding of the Latitude by double altitudes, or to the finding of distances on a great circle.

In the following examples* the *observed* quantities will

* Three only of the nine examples given by the author are printed.—ED.

generally be used, instead of the sides, to which they are complementary. When a side or angle appears as an intermediate result, any further tabular entries depending upon it will be named accordingly, so that in all cases the quantities in hand will be used unchanged. The data will be taken from Raper's *Navigation*, sixth edition.

Formula (1).

Ex. 1. Alt. $37^{\circ} 51'$; Lat. $51^{\circ} 10' N.$; Decl. $19^{\circ} 27' N.$

Find the hour-angle. (Raper, page 202.)

Alt.	$37^{\circ} 51'$	sin	9.78788		
Lat. N.	$51^{\circ} 10'$	cosec	0.10848	tan	0.09422
Decl. N.	$19^{\circ} 27'$	cosec	0.47758	tan	9.54794
		log x	0.37394	log $(x - 1)$	0.13532
Hour-angle	$3^h 32^m 47^s$			cos.	9.77748

Here $x = 2.3656$, and the sides are each less than 90° , therefore the log of $(x - 1)$, i.e., the log of 1.3656 is added to the log tangents. It will be observed that the latitude and declination are of the same name.

Formulae (1) and (2) combined.

Clearing a lunar distance.

Ex. 7. App. Alt. $\odot 47^{\circ} 31'$; True Alt. $47^{\circ} 30' 13''$
 App. Alt. $\sphericalangle 36^{\circ} 52'$; True Alt. $37^{\circ} 37' 35''$
 App. Distance $48^{\circ} 20' 29''$

Find the true distance. (Raper, page 289).

App. Dist.	$48^{\circ} 20' 29''$	cos	9.82261		
App. Alt. $\odot$	$47^{\circ} 31'$	cos	0.13225	tan	0.03820
App. Alt. $\sphericalangle$	$36^{\circ} 52'$	cos	0.22182	tan	9.87501
		log x	0.17674	log $(x - 1)$	9.70091
True Alt. $\odot$	$47^{\circ} 30' 13''$			cot	9.96200
True Alt. $\sphericalangle$	$37^{\circ} 37' 35''$			cot	0.11308
				log y	9.68920
				log $(y + 1)$	0.17286
True Dist.	$47^{\circ} 55' 00''$			cos	9.82621

In the first part of this example, $x = 1.50224$, and $(x - 1) = 0.50224$; and in the second part, $y = 0.48888$, and

$(y + 1) = 1.48888$. The latter part is in effect the converse of the former part, with the true altitudes substituted for the apparent altitudes. As $(x + 1)$ was used in the former part, so $(y - 1)$ is used in the latter part.

Formulae (1), (2), and (3), combined.

Latitude by Double Altitudes.

Ex. 9.	Markab R.A.	$22^{\text{h}} 57^{\text{m}} 44^{\text{s}}$	Decl. $14^{\circ} 27' \text{N.}$	True Alt. $58^{\circ} 55'$
	Altair R.A.	$19^{\text{h}} 43^{\text{m}} 53^{\text{s}}$	Decl. $8^{\circ} 30' \text{N.}$	True Alt. $23^{\circ} 30'$

Find the latitude and the hour-angles. (Raper, page 255.)

Polar Angle	$3^{\text{h}} 13^{\text{m}} 51^{\text{s}}$	$\cos 9^{\circ} 82' 159$		$\sin 9^{\circ} 87420$
Decl.	Markab	$14^{\circ} 27'$	$\cot 0^{\circ} 58891$	$\sin 9^{\circ} 39713$
	Altair	$8^{\circ} 30'$	$\cot 0^{\circ} 82550$	$\sin 9^{\circ} 16970$
				$\cos 9^{\circ} 99520$
	$x = 17.219$	$\log x 1.23600$	$\log (x + 1) 1.26052$	
	Distance	$47^{\circ} 46\frac{3}{4}$	$\cos 9^{\circ} 82735$	$\cos 0^{\circ} 13044$
	A	$88^{\circ} 27'$		$\sin 9^{\circ} 99984$
Alt.	Altair	$23^{\circ} 30'$	$\sin 9^{\circ} 60070$	
	Markab	$58^{\circ} 55'$	$\cos 0^{\circ} 06731$	$\tan 0^{\circ} 21980$
	Distance	$47^{\circ} 46\frac{3}{4}$	$\sec 0^{\circ} 17264$	$\cot 9^{\circ} 95780$
	$y = 0.69287$	$\log y 9.84065$	$\log (y - 1) 9.48732$	
	B	$62^{\circ} 28'$	$\cos 9^{\circ} 66492$	
	(A - B)	$25^{\circ} 59'$	$\cos 9^{\circ} 95372$	$\sin 9^{\circ} 64158$
Markab	Decl.	$14^{\circ} 27'$	$\cot 0^{\circ} 58891$	$\sin 9^{\circ} 39713$
	Alt.	$58^{\circ} 55'$	$\cot 9^{\circ} 78020$	$\sin 9^{\circ} 93269$
				$\cos 9^{\circ} 71289$
	$z = 2.1030$	$\log z 0.32283$	$\log (z + 1) 0.49178$	
	Latitude	$41^{\circ} 32\frac{1}{2} \text{N.}$	$\sin 9^{\circ} 82160$	$\sec 0^{\circ} 12582$
	Hour-angle of Markab	$1^{\text{h}} 10^{\text{m}} 21^{\text{s}}$		$\sin 9^{\circ} 48029$
	Altair Alt.	$23^{\circ} 30'$	$\sin 9^{\circ} 60070$	
	Lat. N.	$41^{\circ} 33'$	$\cos 0^{\circ} 17831$	$\tan 9^{\circ} 94757$
	Decl. N.	$8^{\circ} 30'$	$\cos 0^{\circ} 83030$	$\tan 9^{\circ} 17450$
	$x =$	$\log x 0.60931$	$\log (x - 1) 0.48676$	
	Hour-angle of Altair	$4^{\text{h}} 24^{\text{m}} 7^{\text{s}}$	$\cos 9^{\circ} 60883$	

The difference of these hour-angles $3^{\text{h}} 13^{\text{m}} 46^{\text{s}}$, differs from the polar angle by 5^{s} only. The computed latitude may therefore be relied on. It may be observed that the latitude by account is not an element of our calculation.

The angle marked A, is the angle at *Markab*, subtended by

the arc between *Altair* and the Pole; and the angle marked B, is the angle at *Markab*, subtended by the arc between *Altair* and the Zenith. The difference of these ($A - B$) is the angle of position of *Markab* at the time of the observation. We might in this case, with equal correctness, have determined the latitude by means of the corresponding angles at *Altair*.

The methods herein shown may deserve attention. A little practice would render them familiar, and they require no special tables. Printed forms would also assist the memory and reduce the amount of work.

Trigonometric tables should always have Time arguments. Dr. Inman's, to every second of time, is, for nautical use, extremely convenient. Tables of $\log(1+x)$ and $\log(1-x)$, such as those of Mr. Gray, might advantageously be applied to the foregoing processes.

Occultation of α Cancr, observed at Highbury.

By T. W. Burr, Esq.

1863, April 26th. The star α *Cancr* disappeared instantaneously at the dark limb of the Moon at $12^h 1^m 18^s$, corrected Local Sidereal Time. The reappearance was not observed. Telescope 4 ft. 4 in. focus, $3\frac{3}{8}$ inches aperture. Power 123. Longitude, 24^s W.

Highbury, May 5th, 1863.

Remarkable Phenomenon attending the Lunar Occultation of α Cancr, on the 26th April, 1863. By the Rev. W. R. Dawes.

The disappearance of α *Cancr* at the Moon's dark limb, on the evening of the 26th ult., was observed at West Gorton, near Manchester, by Mr. Ralph Copeland, with a 5-inch refractor by Messrs. T. Cooke and Sons; and the next day the following account of the observation was communicated to me by the observer:—

“The disappearance was very remarkable. About three-fourths of the light disappeared in the usual instantaneous manner; and after an interval of (as near as I could judge) rather more than half a second, the remaining portion disappeared. I did not observe the reappearance.”

In a subsequent letter Mr. Copeland says :—“ I was so surprised at the totally unexpected phenomenon, that I cannot give the *time*” [*i. e.* the interval between the partial and the total disappearance] “great weight ; but I am certain that it was less than one second.”

As such a phenomenon points distinctly to the duplicity of the star occulted, I have carefully examined it, under the best circumstances which have since occurred, with my $8\frac{1}{4}$ -inch refractor. In hopes that the diminution of the disks by strong twilight might enable me to detect a separation of the components which might not be discernible in a dark sky, on May 1st I set my telescope upon it so early as 6^h 22^m G.M.T., the star being about five minutes east of the meridian. The sun was shining brightly ; but the star (of the fifth magnitude) bore sufficiently well a power of 620, and occasionally the disk was tolerably free from tremour and moulding ; yet no separation, or even elongation, could be perceived. Subsequently a power of 1000 was applied, with which the disk was at times well seen, but under the best vision it was perfectly round. The observations have since been repeated, though under circumstances scarcely so favourable, but with the same negative result. It would however, I think, be highly desirable that the star should be examined under the best atmospheric conditions, and with refractors of larger size than my own, of which, happily, there are already several in this country.

Two more occultations of α *Canceri* will occur during the present year, and three in 1864, visible at Greenwich.

As the occultation on April 26th occurred at a convenient time, it may probably have been observed elsewhere ; and if so, it would be interesting to know whether any unusual phenomenon was noticed.

Hopefield Observatory, Haddenham, Thame,
May 6, 1863.

Some Observations of the Lunar Crater Plato.

By the Rev. W. R. Dawes.

Having been requested by Mr. Birt, who has been so diligently engaged in scrutinising the Lunar Crater termed *Plato*, to examine the floor of that crater with the more powerful means at my disposal, I took advantage of a rather favourable night for that purpose immediately succeeding the receipt of his letter on January 31st ; and as some of the points I then made out were, so far as I know, previously unobserved, and subsequent observations have confirmed and extended the discoveries then made, Mr. Birt has requested

me to put the results on record by communicating them to the Society.

Three crater-like spots had previously been noted on the floor of *Plato*; one near the centre, which is the largest; and visible with very moderate optical aid; another toward the south-east; and the third to the north and a little east of the central spot. On the evening above mentioned (Jan. 31st) I noticed that with power 105 this small northern spot was decidedly elongated in an oblique direction, namely, north-east and south-west. On raising the power to 209 I instantly perceived that this apparent elongation arose from the spot being actually *double*, being composed of two very small round crater-like spots, nearly equal in size and brightness, and about one diameter of either apart. All this was seen much plainer with powers from 300 to 620. But whether their circular margins were actually raised above the common level, or whether their interior was depressed below it, I could not determine in the sunlight which then fell upon that part of the moon, her age being about 12.2 days. But on the 26th of April, from 7^h 52^m to 8^h 38^m, G.M.T., I was so fortunate as to catch a good view of *Plato* as soon as the shadows of the western mountainous ridge were withdrawn from the central spot and the small double one to the north, and while the long spire-like shadow of the fine peak on the western ridge was yet stretching completely across the south-eastern portion of the floor; the northern edge of that shadow actually bisecting the small crater situated in that part. Under these circumstances I was gratified to find that the true character of all these spots was fully brought out, and they were proved to be veritable craters. The eastern wall of the central crater cast a decided shadow on the outside, and the western wall cast a small shadow inwards. Precisely the same appearance was visible in each of the components of the double spot, the length of the exterior shadow of each being, as nearly as I could judge, equal to the diameter of either of them. The appearance of the small crater to the south-east was very similar, but was at first interfered with by the edge of the spire-like shadow which rendered it difficult to be certain of all the details. At 10^h 52^m G.M.T., however, the apex of this shadow exactly reached the western wall of the crater, and I was then able to make out features of light and shade precisely like the others, but only by transient glimpses, the Moon being then too near the horizon to bear well sufficient power.

There are many other bright spots and streaks on the floor of *Plato*; but the streaks seem to resemble those which extend from some of the principal craters, and show neither elevation above nor depression below the surface over which they pass; and the brighter patches appear to be merely suddenly enlarged portions of these streaks, being irregular in

outline and destitute of elevation. They are all best seen when the Sun's rays fall nearly vertically upon them; while under very oblique illumination they can scarcely be seen at all.

There are two other extremely small spots, one a little to the south-east of the central crater, the other nearly due east of it, which *may*, from their sharp definition and round form, probably be craters; but they require good circumstances and high powers to see them at all; and I could not, on the 26th ult., discern the slightest shadow from either of them.

Hopefield Observatory, Haddenham, Thame,
May 7, 1863.

On a Portion of the Surface of the Mare Imbrium, observed with the Hartwell Equatoreal. By W. R. Birt, Esq.

The surfaces of most of the so-called lunar seas are characteristically different from all other portions of the lunar surface. A general absence of ruggedness, but few craters, and those only thinly scattered, soft undulating ridges bearing apparently some relation to the borders of the *Maria*, are (with the smaller quantity of light reflected from them) features which at once separate the dusky portions from all others on the lunar hemisphere turned towards the Earth. When the solar light reaches them under a high angle, numerous variations of luminosity are detected, round spots of light that before were invisible manifest themselves, streaks seen to radiate from central craters cross them in various directions, the result being that under a mid-day illumination most of the *Maria* present a well-known mottled appearance, which is scarcely, if at all, observable under either the morning or evening illuminations.

The object of this communication is to place on record a feature by no means so common as any alluded to above. It is a deepening of the tint of the surface, accompanied by a *purity* not to be found in the speckled and mottled surfaces of the *Maria*; and the one I am about to describe appears to be intimately associated with the range of mountains known as the *Alps*, and the bright grounds south and east of *Plato*.

On the evenings of May 2 and 4, 1863, the illumination was sufficiently advanced to bring out, with admirable precision, this deeper tint on the surface of the *Mare Imbrium*. I have thus recorded its appearance at the time of observation: "Bordering the *Alps* from the most extreme end towards the south-west, as far as *Plato*, is a portion of the *Mare Imbrium* of a *pure* dark colour. Its general contour is more or less parallel with the *Alps* and the bright ground which

extends in a gentle curve from the *Alps* to *Plato*. Where this border is not interrupted by streaks or spots, the colour is very pure. In the neighbourhood of the south-east extremity of the wedge-shaped valley of the *Alps* this pure colour extends outwards, so that there is a greater space of purer colour absolutely existing at what may be called the estuary of the valley, as if the convulsion which had produced the valley had interfered with the nature of the surface hereabouts. Just preceding this larger extension of the purer colour the greatest interruption of the border occurs in consequence of some rays which proceed from *Aristillus*, the rays extending nearly across the smoother and darker border. The extension of this pure tint of surface in the opening of the valley is curious, opening out as far into the *Mare Imbrium* as the mouth of the valley indents the general border of the *Alps*. Just eastward of the mouth of the valley this pure border is again interrupted by a lighter portion of the surface, on which stand two small craters, close together, marked K by Beer and Mädler. These craters are slightly removed, towards the east, from a line coincident with the direction of the wedge-shaped valley. Proceeding eastward, this border of a deeper and purer colour meets with no further interruption until it terminates south of *Plato*. It appears to take the general form of the bright ground north of it, but widens out a little towards *Pica*.

“The south-east ascent to the summit of the ring of *Plato* completely obliterates this delicate border. Eastward of the south-east ascent it appears again much contracted towards its eastern end, in close proximity with the bright ground extending from *Plato* to the promontory of *Laplace*, and terminating in a fine point north of the middle of a remarkably straight chain of mountains between *Plato* and *Laplace*. It has considerable breadth where it abuts on the brighter ground of the south-east ascent to *Plato*.”

This border, which is somewhat indistinctly shown on De la Rue's photographs, is best seen a little before or a little after full moon; good definition is requisite to bring it out well, and the eye should be protected by a slightly-tinted glass.

Elements of the Comets II. and III., 1863.

By Mr. Hermann Romberg.

(Communicated by J. Gurney Barclay, Esq.)

Both Comets now visible have been frequently observed here, but the reductions are not yet completed. Observations

may probably be continued till the end of the month. By a preliminary calculation on three Leyton observations the following elements have been obtained:—

Comet II. 1863.

(Discovered by Dr. Klinkerfues.)

T	1863, April 5	04696	Greenwich M.T.
π	247	7 42' 3"	} Apparent Equinox of April 10.
Ω	251	19 32' 4"	
i	67	13 38' 0"	
log q		0.028804	
Retrograde.			

The errors for the middle observation being only

$$\Delta \alpha = + 1''.7 \quad \Delta \delta = + 2''.6 \quad (\text{C.} - \text{O.})$$

These elements agree very closely with M. Löwy's, published in the Paris *Bulletin* for April 30. The Comet's appearance is that of a round nebula strongly condensed in the middle, and having a very faint nucleus. It was easily observed during moonlight.

Comet III. 1863.

(Discovered by Prof. Respighi at Bologna.)

For this Comet I have calculated from one Berlin and two Leyton observations the following elements:—

T	1863, April 22	33050	Greenwich M.T.
π	296	53 49' 3"	} Apparent Equinox of April 20.
Ω	241	14 35' 8"	
i	84	36 18' 9"	
log q		9.788234	
Direct.			

The appearance of this Comet is much more interesting than that of the second: for the week following April 19 it was a very brilliant little object with low powers on the refractor. It is now visible during the whole night near the northern horizon, and may be observed on the meridian at its transit *sub polo*.

Mr. Barclay's Observatory, Leyton,
May 6.

Observations of the Comets II. and III., 1863.

By R. Hodgson, Esq.

Comet II. 1863.

1863.	G.M.T. h m s	R.A. h m s	Decl. ° ' "
April 20	12 2 13	20 27 0	+ 15 42 ±

Apparent size about 4' of arc, with a bright condensed nucleus.

May 1	13 1 0	19 57 54	+ 50 8 ±
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Less bright than on April 20.

4	11 40 0	19 42 38	+ 57 57 ±
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Fast diminishing in brightness.

Comet III. 1863.

1863.	G.M.T. h m s	R.A. h m s	Decl. ° ' "
April 26	13 50 45	0 33 11	+ 42 1 ±

A beautiful object, very brilliant, and a miniature of Donati's Comet; decided stellar nucleus, and tail of at least a degree in length; visible to the naked eye.

	G.M.T. h m s	h m s	Decl. ° ' "
May 7	14 0 0	2 3 28	+ 47 35 ±

Much less brilliant, and not observable with the naked eye.

*Grove House, May 8, 1863.**Observations and Parabolic Elements of Comet III. 1863.*

By M. Karlinski.

	Cracow M.T. h m s	Comet's App. R.A. h m s	Log $\left(\frac{P}{\Delta}\right)$	Comet's App. Decl. ° ' "	Log $\left(\frac{P}{\Delta}\right)$
1863.					
April 18	15 5 54.7	23 25 53.18	9.6264	+ 30 44 18.9	0.7803
20	14 3 1.5	23 41 34.26	9.6005	34 3 28.6	0.8308
„	14 28 11.6	23 41 42.60	9.6208	34 5 13.3	0.8104
21	14 26 44.9	23 79 57.95	9.6249	35 37 13.1	0.8114
23	14 3 26.4	0 6 44.31	9.6116	38 21 19.1	0.8326
May 2	14 18 18.1	1 24 7.05	9.6299	45 48 47.2	0.8377
4	13 32 59.2	1 39 47.07	9.5411	46 34 31.4	0.8772
5	13 41 50.2	1 47 38.05	9.5553	+ 46 52 3.7	0.8730

Parabolic Elements, computed with regard to Parallax and Aberration, from the observations of 18, 20, and 23 April, are

$$\begin{array}{rcl}
 T & = & 1863, \text{ April } 20^{\circ} 89771 \text{ Berlin M.T.} \\
 \alpha & = & 305^{\circ} 31' 56'' \\
 \delta & = & 279^{\circ} 59' 21.7'' \\
 i & = & 85^{\circ} 28' 73.5'' \\
 \log q & = & 9.798266
 \end{array}
 \left. \vphantom{\begin{array}{l} \alpha \\ \delta \\ i \end{array}} \right\} \text{Mean Equinox } 1863^{\circ} 0$$

Motion direct.

Cracow, May 6, 1863.

RECENT PUBLICATIONS.

Observations de la Grande Nébuleuse d'Orion faites à Cazan et à Poulkova. 1^{re} Partie. Mémoire de M. Liapounov sur les Observations de Cazan. 2^e Partie. Additions au Mémoire de M. Liapounov, et Observations de Poulkova. (Avec 4 planches). 4to. St. Pét. 1862, pp. 1-122; forms part of t. v. of the Mémoires de l'Académie de St. Pétersbourg, vii^e Série.

The chief object of M. Liapounov's Memoir is the construction of a Catalogue of the exact positions of the visible stars of the Nebula, to serve as a point of departure for ulterior researches on the nature of this magnificent star—researches for which a solid basis was given by the labours of Sir John Herschel at the Cape. In the course of his work the author has collected some detached observations, made under favourable atmospheric circumstances, on the regions of the Nebula most accessible by their brilliancy to the power of his telescope; and the results of these observations are given at the end of the Memoir. He remarks, however, that, under the less favourable conditions of his station, such researches presented great difficulties, and that, for this reason, he considers the last-mentioned results as only provisionally established.

The observations were continued regularly in the years 1847-1851, with a single break in the year 1850. The space surveyed, in the neighbourhood of θ Orionis, was about 0.12 of a square degree; whereas the telescope of Sir J. Herschel gave to the Nebula an extent almost double, 0.22 of a square degree.

The stars made out in the space indicated were at first 56 in number; this number was increased to 78 by the successive discovery of some more feeble stars. Five more stars,

situate a little beyond the limits mentioned, were afterwards added, making together 83 stars the relative positions of which were to be determined by micrometric measures; but some other stars were observed, making in all 125 out of the 150 stars of Sir J. Herschel; and besides two stars, one of the 9th magnitude, probably excluded by Herschel on account of its too northerly position, the other a star of the 12th magnitude, which is wanting also in the catalogue of Prof. Bond. The Catalogue of the definitive positions in regard to θ Orionis of the other 82 stars, is given (pp. 61-63); and the results are compared with those of Herschel and Bond, and of M. Lamont. The concluding part is occupied with physical observations of the Nebula, a drawing of which is given in Plate III.; but it is remarked that the artist has found much difficulty in suitably expressing the relative intensities of the different regions.

The second part, by M. Otto Struve, is in a great measure supplementary to the other. It contains a comparison of M. Liapounov's results with those of Mr. Lassell, obtained by him at Malta in the years 1852 and 1853 (*Mem. R. Ast. Soc.*, t. xxiii.), and a supplementary comparison with the results of Herschel, Bond, and Lamont, and with some other ancient and modern observations. It contains, also, M. Struve's own observations at Pulkova in the years 1856-1862, and, in conclusion, a single Catalogue of the positions in respect to θ Orionis of all the stars the existence whereof has been verified with the Refractor at Pulkova. The Catalogue contains, in the order of their Right Ascensions, all the 150 stars of Herschel and 5 supplementary stars. For all the 82 stars measured by Liapounov, the positions are borrowed from his Catalogue; 59 others are introduced, according to the measures and estimations of Herschel, 3 from Lassell's Catalogue, and 1 from that of Bond; for 10 stars the positions are given, such as they were determined at Pulkova. The Plate IV. gives a graphical representation of the relative positions of the stars in the Catalogue, sufficiently accurate to serve for comparison with the heavens, or for the construction, by its aid, of exact drawings of the Nebula.

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